

The Risk of Loan Consuming by SMEs Based on the Supply Chain

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Abstract

For the high bad-loan ratio of SMEs, banks are increasingly cautious to provide loans to SMEs. Based on the asymmetric information theory, we put forward the concept of "loan consuming radius (LCR)" from the depth dimension of supply chain. Then we characterize the loan risk of SMEs by this new concept.

Keywords

Loans of SMEs; Loan Risk; Supply Chain; Loan Consuming Radius (LCR)

Introduction

Bad loan ratios of large, middle and small enterprises are 1.1%, 2.8% and 6.0% respectively since September, 2009 (Zhang, 2009). Moreover, bad loan ratios of in middle and small enterprises are larger than that in large enterprise by 155% and 445%. According to literature, pre-loan supervision (30%), post-loan management (40%) and default of debtor (30%) are three main factors make up bad loan ratios (Shang, 2011). Many bad loans were caused by lacking of systematic management of loan consuming in the post-loan management.

One of scarce files that clarify loan consuming is "Loan statistical classification and coding standard" published by the People's Bank of China.¹ This file includes data item of "direction of loan consuming", which includes 398 types (396 types in GB/T, personal loan and offshore borrowing). It should be note that the above information is totally text description.

According to the practice of one small-loan enterprise in Chongqing, we found that more than 95% loans were consumed as liquidity loan without direction, and they were roughly classified into 2 types - "Normal" and "Special-mentioned". In addition, in a commercial bank branches in Beijing, loan was graded

into 15 levels², and loan rating system is a kind of access permit system. The loan releasing and consuming for SMEs of this bank was as follows³: loan was mainly released to trade enterprises and technology services companies, and the "trade" loans were released through "earmarking and entrusting" types, at the same time, the loan consuming companies needed to provide appropriate procurement contracts, payment invoices and other kinds of commercial documents; besides, loans could be divided into working capital loans (account for 90%) and fixed asset loans.

In general, the description of loan consuming was limited to described text file; however, such kind of information could not be used directly for measuring the risk of loan. For measuring and quantifying the loan risk, we put forward the concept of "loan consuming radius (LCR)". Our goal is to objectively measure the risk of lending to SMEs, thus revealing the facts of loan consuming companies, reducing information asymmetry between banks and enterprises, and improving the level of risk control of loans to SMEs.

Loan Consuming Radius

Structure of supply chain affects its cost and efficiency. Lambert et al. (1998) gave a network model of supply chain for the first time, which was showed as figure 1.

Definition 2.1 Horizontal Rank of Supply Chain With the loan-consuming company as the origin, we rank the upstream companies and number them as follows: number the loan-consuming company as 0; the first upstream company as ¹; the second upstream company as ², and so on. Moreover, we call the number as the company's rank.

² 15 levels were AAA, AA+, AA, AA-, A+, A, A-, BBB, BB, B, CCC, CC, C, D1 and D2.

³ For limiting to some conditions, we cannot do a large scale of investigation, so the existing research results only take certain statistically significant.

¹ See: http://www.pbc.gov.cn/publish/diaochatongjisi/866/2010/20100610143325363244284/20100610143325363244284_.html, visited at June, 2010.

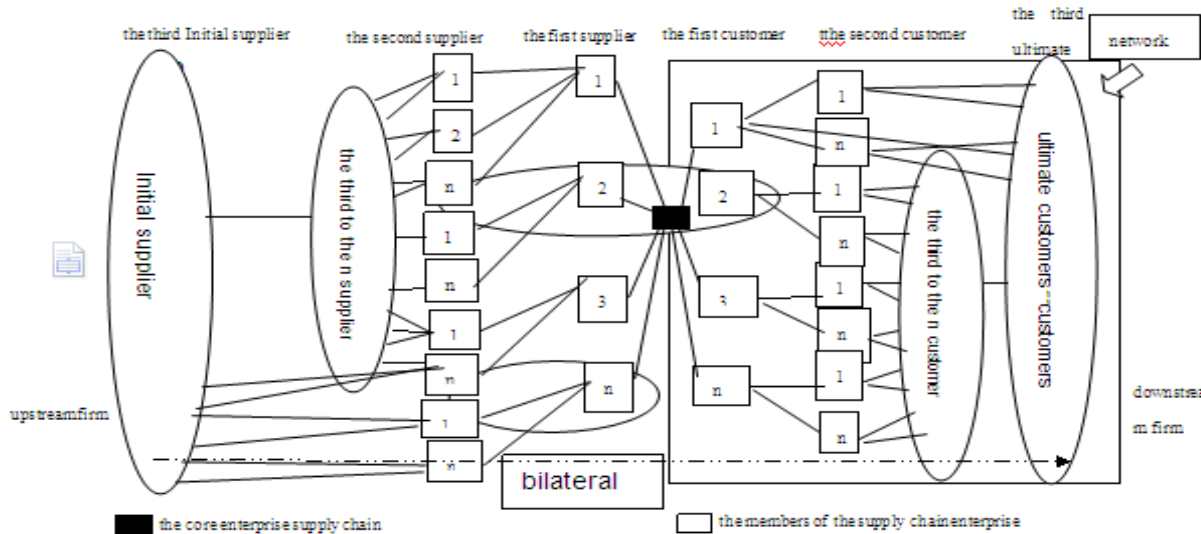


FIGURE 1 NETWORK MODEL OF SUPPLY CHAIN

By analyzing the survey result, we find that the loan that SME obtained is mainly used in the upstream companies. For suiting to real situation, we only consider the use of the loan in the upstream companies.

Definition 2.2 Loans Consuming Radius (LCR) Ranking the companies according to the horizontal rank of the supply chain, the LCR is the loan consuming company's rank if the loan is use totally to one upstream company in supply chain, and the sum of all the upstream companies' ranks with proportion of the loan as weighted factor if the loan is used to more than one loan consuming company.⁴

According to the definition, LCR describes the using scope of a loan in the supply chain. Bigger LCR means larger scope of loan consuming company in the upstream companies, or bigger proportion of loan to upstream companies in the supply chain. Meanwhile, a bigger LCR also implies mostly more potential upstream companies which can use the loan in the supply chain. Therefore, bigger LCR indicates larger distance between the loan crediting company and the loan consuming company, and looser bond between them, which means loan crediting company, has weaker influence to loan consuming company. As a result, we have the following facts for bigger LCR.

1) The company (creditor) will pays more cost to fabricate "application report" or false loan purpose in the pre-loan period. Also it's easier for the bank (debtor) to recognize the company's defrauding. Therefore, the distance between the loan crediting

company and loan consuming company is larger and the loan crediting company has a lower influence to loan consuming company when LCR is bigger, thus the cost to fabricate an application report is bigger. On the other hand, if LCR is larger, the tight between the loan crediting company and loan consuming company is looser, thus the bank has more loopholes to see in the review process and find loan crediting company's false information more easily.

2) The bank will pays more cost to oversee and supervise the loan consuming company in the post-loan period. A bigger LCR means more companies with higher ranks are involved in the process, and the number of the potential loan consuming company⁵ is bigger. It's harder for the bank to screen the truth of where the loan is being used.

Denote r as loan consuming radius, $c(r)$ as post-loan supervision cost of bank (debtor), $d(r)$ as pre-loan cheating cost of loan crediting company (creditor). Based on discussions above, we assume that:

Assumption 2.1: The pre-loan cheating cost of creditor who manufactures false information increases in loan consuming radius, i.e., $d'(r) > 0$.

Assumption 2.2: The post-loan supervision cost of debtor (bank) increases in loan consuming radius, i.e., $c'(r) > 0$.

Relationship between Loan Risks and Loan Consuming Radius in SME

Based on assumptions 2.1 and 2.2, we model the

⁴ From the view of pure theory, we can number the down-stream firms of the loan-consuming enterprise, and the corresponding LCR can also be defined similarly.

⁵ This could be found from Figure 2.1. To the loan-consuming enterprises, the farther away, the more enterprises.

relationship between loan risks and LCR from the view of pre-loan-cheating risks and post-loan-diverting risks⁶ by constructing pre-loan “cheating-supervising” model and post-loan “diverting-supervising” model.

LCR and Pre-loan Risks

Classic theories support that pre-loan risks mainly result from poor quality of company, then usual methods of pre-loan-supervising are expert evaluation methods such as 5C⁷ factors analysis or 5P⁸ factors analysis, which evaluate company's "quality" or capacity of loan paid off⁹ to assess the pre-loan risks. However, one important but ignored in practice risk factor lies in poor-quality company make maliciously false information to apply for loans.

TABLE 1 PAYOFF PAYOFF OF BANK AND COMPANY IN PRE-LOAN GAME

Bank Company		Recognized ($P(c)$)	Not Recognized ($1-P(c)$)
Cheating Company(p)	Cheat	$-d(r), -c$	$1-d(r), -(1+c)$
	Not Cheat	$0, 0$	$0, 0$
Non-cheating Company ($1-p$)	Normal Loan	$R^H - R, (1+R) - c$	$R^H - R, (1+R) - c$

Where R_H is normal rate of return of non-cheating company and R_L is loan interest rate.

We assume that cheating company and non-cheating company account for p and $1-p$ respectively, the non-cheating company can always certify he is not a cheater but the cheating company cannot. Moreover, we assume that cheating company may be recognized by bank with probability $P(c)$, where c is the supervising cost of the bank. Obviously, bigger supervising cost means more exhaustive supervision to company, in which cheating company are distinguished more easily from non-cheating ones, i.e., we have $P(c) > 0$. Then the payoff matrix is showed as table 1.

According to table 1, we can calculate easily the bank's and company's expected revenue as follows:

The bank's expected revenue is

$$\begin{aligned}\pi_B &= -cpR(c) - (1+c)p[1-P(c)] + (1-p)[P(c) + (1-P(c))](1+R-c) \\ &= pR(c) - c + (1+R-2p-pR)\end{aligned}$$

⁶ SMEs have incentive to divert loans to higher risk and higher (expected) revenue investment project other than their pre-loan report.

⁷ 5C factors include Character, Capital, Capacity, Collateral and Conditions.

⁸ 5P factors include People, Payment, Purpose, Protection, Prospects.

⁹ Capital in 5C factors and Purpose in 5P factors analyze loan consuming and company's liabilities.

Cheating company's expected revenue is

$$\pi_{FCheat} = -d(r)P(c) + [1-d(r)][1-P(c)] = 1 - P(c) - d(r)$$

And non- cheating company's expected revenue is

$$\pi_{\text{EnoCheat}} = R^H - R$$

Obviously, non-cheating company is not influenced by pre-loan supervision of bank and obtain normal loan to investment according to the application report, he obtains expected revenue $R_H - R$. As the same time, the bank will choose an optimal supervising cost by maximizing his expected revenue as follows

$$\max_c \pi_B = pP(c) - c + (1 + R - 2p - pR)$$

The first order necessary condition for the maximizing problem is $P'(c) = 1/p$. Let $P'(c^*) = 1/p$, then c^* is the optimal pre-loan supervising cost of bank, in which the cheating company's precondition for cheating is $\pi_{ECheat} = 1 - P(c^*) - d(r) \geq 0$, i.e. $d(r) \leq 1 - P(c^*)$ (1)

Therefore, cheating company has incentive to cheat only under which the pre-loan cheating cost $d(r)$ is small sufficiently (no more than the optimal probability of not-recognized, $1 - P(c^*)$). Since bigger LCR means bigger pre-loan cheating cost $d(r)$ by assumption 2.1, thus (1) holds more hardly for bigger LCR, i.e., company with bigger LCR has lower probability of cheating. On the other hand, the bigger LCRs are, the less companies satisfying condition (1) are, then the probability of pre-loan cheating is lower. Therefore, there is a reverse relationship between LCR and pre-loan-cheating risks.

LCR and Post-loan Risks

After approving loan, bank can disburse loan without supervision or examine loan by cost $c(r)$. At the same time, company can divert loans to higher risk and higher (expected) revenue investment project other than their pre-loan report or use loans according to the report. We assume that company obtains 1 unit loan from the bank. Company will get a lower profit RL if he use the loan truthfully and a higher profit RH with a probability P if he divert his loan to higher risk and higher (expected) revenue investment project.¹⁰ Denote R be the interest rate, then we assume naturally that $RH > RL > R$. When divert loans of company are discovered by bank, the principal and interest will be withdrawn and the company will be imposed a fine $1+R$. Therefore, the payoffs matrix of bank and company in post-loan game are showed as table 2:

¹⁰ Because the loan amount is 1, so R^L and R^H stand for ROI (return on investment) of loan program and high-risk projects respectively.

TABLE 2 PAYOFFS OF BANK AND COMPANY IN POST-LOAN GAME

Bank \ Company	Supervise	Not Supervise
Not Divert Loans	$R^L - R, 1 + R - c(r)$	$R^L - R, 1 + R$
Divert Loans	$-1 - R - c^2(r), 1 + R + c^2(r) - c(r)$	$(R^H - R)P, (1 + R)P$

Following the usual method in Game Theory, it is easy to know that the post-loan game described in table 2 has no pure strategy Nash equilibrium. As a result, we will find the mixed strategy Nash equilibrium for it.

We assume that bank's and company's mixed strategies are $(\lambda, 1-\lambda)$ and $(\sigma, 1-\sigma)$ respectively, i.e., the bank will take supervision measure with probability λ and the company will not divert loans with probability σ . Then bank's and company's expected revenue under such strategies are as follows:

$$\pi B = \sigma\lambda[1+R-c(r)] + \sigma(1-\lambda)[1+R] + (1-\sigma)\lambda[1+c2(r)+R-c(r)] + (1-\sigma)(1-\lambda)[(1+R)P] \quad (2)$$

$$\pi E = \sigma\lambda[RL-R] + \sigma(1-\lambda)[RL-R] + (1-\sigma)\lambda[-1 - c2(r)-R] + (1-\sigma)(1-\lambda)[(RH-R)P] \quad (3)$$

Given company's mixed strategy $(\sigma, 1-\sigma)$, bank will choose an optimal λ to maximize his expected revenue πB at the mixed strategy Nash equilibrium. Then we get the first order necessary condition

$$\frac{\partial \pi_B}{\partial \lambda} = \sigma[1+R-c(r)] - \sigma[1+R] + (1-\sigma)[1+c2(r)+R-c(r)] - (1-\sigma)[(1+R)P] = 0$$

And then have the company's optimal mixed strategy

$$\sigma^* = \frac{c^2(r) - c(r) + (1+R)(1-P)}{c^2(r) + (1+R)(1-P)} \quad (4)$$

Similarly, we can get the first order necessary condition of company's maximizing his expected revenue for given $(\lambda, 1-\lambda)$

$$\frac{\partial \pi_E}{\partial \sigma} = \lambda[RL-R] + (1-\lambda)[RL-R] - \lambda[-1 - c2(r)-R] - (1-\lambda)[(RH-R)P] = 0$$

And then have the bank's optimal mixed strategy

$$\lambda^* = \frac{(R^H - R)P - (R^L - R)}{R + 1 + c^2(r) + (R^H - R)P} \quad (5)$$

By (4) and (5), company's optimal mixed strategy depends on interest rate R , success rate of high risk project P and bank's supervision cost $c(r)$, and bank's optimal mixed strategy depends on ROI of high risk project RH , ROI of the loan project RL , interest rate R ,

success rate of high risk project P and bank's supervision cost $c(r)$. Since the post-loan risks are mainly from company's diversion, thus we can just analyze the relationship between LCR and the company's probability of diverting loans σ .

Take the partial derivative of (4) with respect to $c(r)$, we have

$$\frac{\partial \sigma^*}{\partial c(r)} = \frac{c^2(r) - (1+R)(1-P)}{[c^2(r) + (1+R)(1-P)]^2} > 0$$

And then

$$\frac{\partial \sigma^*}{\partial r} = \frac{c^2(r) - (1+R)(1-P)}{[c^2(r) + (1+R)(1-P)]^2} c'(r) > 0 \quad (6)$$

By (6), the bigger LCR is the more probability of non-diverting is at equilibrium, i.e., bigger LCR means lower probability of diverting loans to high risk project. Therefore, there exists a reverse relationship between LCR and post-loan diverting risks, i.e., bigger LCR is, less risks are.

In addition, it is easy to get from (2) by envelope theorem:

$$\begin{aligned} \frac{d\pi_B}{dr} \Big|_{\lambda=\lambda^*, \sigma=\sigma^*} &= -\sigma\lambda c'(r) - (1-\sigma)\lambda c'(r) + 2(1-\sigma)\lambda c(r)c'(r) \Big|_{\lambda=\lambda^*, \sigma=\sigma^*} \\ &= -\lambda c'(r) + 2(1-\sigma)\lambda c(r)c'(r) \Big|_{\lambda=\lambda^*, \sigma=\sigma^*} \\ &= [2(1-\sigma)c(r) - 1]\lambda c'(r) \Big|_{\lambda=\lambda^*, \sigma=\sigma^*} \\ &= [2(1 - \frac{c^2(r) - c(r) + (1+R)(1-P)}{c^2(r) + (1+R)(1-P)})c(r) - 1]\lambda^* c'(r) \\ &= \frac{c^2(r) - (1+R)(1-P)}{c^2(r) + (1+R)(1-P)} \lambda^* c'(r) \\ &> 0 \end{aligned}$$

Thus, the expected revenue of banks will increase with LCR, i.e., bigger LCR benefit bank's revenue, too.

Conclusion and suggestion

Conclusion

Based on the structure of supply chain, this paper constructs a new indicator for loans risk assessment of SME: the Loans Consuming Radius (LCR). And we analysis the relationship between LCR and loan-consuming risk from two perspectives of pre-loan and post-loan, and we found that it was an inverse relationship between LCR and loan risks. Our work affords preliminary theoretical foundation of the use of LCR. Increasing LCR can effectively reduce the risks of pre-loan defrauding, as well as post-loan misappropriating. Thus it could effectively reduce the risk of bank loans.

Suggestion

1) *Realize Management of Loans to SMEs in three-phase*

a) Strengthening loan reviewing in the pre-loan period. The loan reviewing should contain a detailed qualification examination about the SMEs, together with application analyses about the use of the loan, to ensure SMEs' loan repayment capacity as well as the rationality of loan purpose. Moreover, we can use the inverse relationship between LCR and loan risks to conduct a further quantification to reduce the defrauding of the "un-qualified" SMEs in the process of the loan review.

b) Specifying contract in the during-loan period. The current contract items of the loan contracts are not specific enough in the term of the purpose of the loan, for instance, many contracts only indicate "liquid fund loan" or "purchase raw material" when it comes to the purpose of loan, it leaves a loophole for the possibility of misappropriation of loan. Therefore, the bank should regulate and specify the terms concerned the loan purpose in the contract, in order to reduce the misappropriation.

c) Emphasizing the overview in the post-loan period. First, establishing a system to follow and check out the use of the loan to make sure the purpose of the loan didn't get changed. SMEs should provide materials to prove the reasonable use of loan (fully perform the contract provisions) and to clear the terms that affect SMEs' repayment capacity (such as some important event happened in the SMEs), and follow the bank's instructions. All of these can make sure the loan is used to keep running, and prevent from being misappropriated. Then, improving and standardizing the content of loan review report. Using the LCR and other indicators to quantify the risk of post-loan misappropriation, analyses the problem qualitatively and quantitatively.

2) *Innovation of Information management mode for SMEs loan*

On the base of building a system contains shared information inside and outside the bank, changing the way to gather information of SMEs' loan. As point out by Li Anyu(2011), the authentication of disclosing SMEs' information has become a key feature to determine whether the transaction of companies will continue successfully. Meanwhile, enterprise credit transparency index is based on the

disclosure of the company's information actively or passively, and the index is designed to evaluate the extent of disclosure and credit situation of the SMEs.

It is suggested that the bank should change its' way from "following loan" to "actively disclosure of SMEs". In this way, banks can learn about the information dynamically, reduce the cost of supervising the use of loan and use the advantage of network - fast transmission of information, convenient transactions, low cost and so on - to realize the online monitor of loan risk from large numbers of the SMEs.

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